



Taylor Engineering

LLC

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January 2, 2003

Bill Pennington
California Energy Commission
1516 9th Street, MS 25
Sacramento CA 95814

Subject: December 20, 2002 Letter from Peggy Jenkins, ARB

Dear Bill:

I am writing to respond to issues with the proposed DCV requirement raised by Peggy Jenkins of the Air Resources Board in her December 20th, 2002 letter to Bryan Alcorn. As detailed below we understand Ms. Jenkins' concerns but feel that the requirement as written sufficiently addresses her issues. We hope this letter will address her concerns.

Before I address Ms. Jenkins concerns individually I would like to establish a few facts regarding the proposed DCV requirement as it is presently written:

1. DCV is not a new requirement; it is an expansion of an existing requirement. DCV is presently required for densely occupied spaces (10 square foot per person or less) in the 2001 Standards (Section 121(c)3). ASHRAE Standard 90.1-2001 has a similar requirement (Section 6.2.3.8).
2. The rationale for DCV is included in ASHRAE Standard 62, Appendix D. This Appendix includes the basis for the 700 ppm CO₂ control differential between space CO₂ levels and the outside air levels.
3. We are proposing a specific exemption for classrooms (Exception to 121 (c) 3 B).
4. Both ASHRAE Standard 62 (in pending addendum 62n) and Title 24 have two tests for minimum ventilation requirements: the first addresses building borne contaminants, it is a fixed rate per square foot of floor area; the second addresses body odor and bioeffluents, it is a fixed ventilation rate per person. Both the existing and proposed DCV requirements allow the second rate to vary with CO₂ levels but no less than the fixed ventilation rate for building borne contaminants.
5. The proposed requirement is only for densely occupied spaces (40 square foot per person and less). In these spaces the design ventilation rates are driven by the occupant (bioeffluent) portion of the ventilation standards. The DCV adjusts this ventilation rate dynamically to the actual occupant density. The proposed requirement does not cover office buildings and other less dense occupancies where the ventilation rates are set for the building borne contaminants.
6. The existing and proposed DCV requirements do not supplant the preoccupancy purge requirements in the Standard (Section 121 (c) 2). This can be accomplished by setting the time control to one hour before the normal occupancy (e.g. if the building is normally occupied at 8am, the system is started at 7am and morning warm-up would occur

between 6am and 7am). This simple change in the time setting forces the HVAC system to provide the code required ventilation for 1 hour prior to building occupancy.

7. The bulk of the problems described in AEC's PIER research on packaged units are due to failures in air-side economizer operation and misapplication of residential thermostats on packaged units. Neither of these issues will be adversely impacted by the addition of demand ventilation controls. These issues are effectively addressed by the new proposed performance verification requirements (sections 121(f), 122(h), 144(d)4 and a new acceptance requirement specifically for DCV - new section 121(c)5)) and through enforcement of the existing requirements.
8. The CO₂ sensor and DCV technology has greatly improved over the past 5 years. There are current significant advances that should be considered:
 - The widespread application of non-dispersive infrared sensors eliminates the sensor poisoning from paint fumes that plagued the surface effect technologies.
 - Advances in sensor technology and self-calibration techniques (almost all of the manufacturers certify their sensor's calibration for 5 years or more and Telsire has a life-time guarantee)
 - Standardization of controls: almost all HVAC manufacturer provide a "factory installed and programmed" option for DCV. DCV controls are available as a premanufactured add-in for packaged economizers (offered by Canfab and Micrometal), they are integrated into Honeywell's economizer control module, and the major DDC control manufacturers (Johnson, Honeywell, and others) have standard sequences. Carrier, McQuay, Lennox, AAON and York all have DCV either as a standard option or an integral part of their products.
9. The proposed DCV requirement includes provisions to assure that the sensors are correctly applied: they require the sensor to be located in the space at the breathing level; they require manufacturers to certify that the sensor calibration is accurate for a minimum of 5 years; and they require one sensor in each densely occupied space served by the system.
10. The CO₂ sensor provides active feedback that can be used as a diagnostic tool for detecting failure of the outside air economizer or balancing issues with the minimum ventilation. Without DCV there is no way for the occupants to know if the economizer is working or if the ventilation damper was adequately balanced.
11. The application of DCV on single zone systems is now routine. Most of the current research is focused on multizone applications. The proposed requirement only covers single zone systems.
12. This technology is mature. According to Mike Schell (previously of Telsire) there are between 60,000 and 100,000 DCV sensors installed annually in the US. The world market is approximately twice this. Mike believes that over 80% of new theaters include DCV as a standard.
13. DCV is recognized in other codes including the International Mechanical Code.

14. CO₂ is not a contaminant of concern in non-industrial buildings; it is an indicator of human bioeffluent concentration and can be used as an indication of ventilation rates per person. OSHA's TWA exposure for CO₂ is 5,000 ppm for an 8 hour exposure.
15. The 700 ppm differential between space and outdoor concentrations of CO₂ correspond to 15 cfm/person at a metabolic rate of 1.2 mets. This meets the current ventilation requirements from Title 24 (Section 121 (b) 2 B). An 800 ppm setpoint is equivalent to ~25 cfm/person.

In response to the specific comments in Ms. Jenkins letter I will refer to my previous points by number.

- **Reliability of DCV Systems:** DCV technology is mature and well integrated into current control products (both premanufactured and DDC systems). It also provides feedback on system operation that can detect some failures of the economizer or minimum ventilation dampers. This is covered by points 7, 8, 9 and 10 above.
- **Incomplete Assessment of DCV Systems:** I am not fully apprised of the scope of Jim Braun's work and therefore am not in a position to assess its relevance to this measure, I have written to Jim and sent him a copy of our proposed requirement for his comment and review. However, the ASHRAE Standard 62 committee, a group recognized throughout the world as experts on indoor air quality, has assessed DCV systems and concluded that they are a reliable means for control. They published Appendix D precisely to provide guidelines in application of DCV systems. Steve Taylor, past chair of Standard 62, co-wrote the proposed requirement. Andy Persily, present chair of Standard 62 has reviewed the proposed requirement.
- **Incomplete Basis for CO₂ Limits:** The 700 ppm setpoint is based on research; it is referenced in Appendix D of ASHRAE Standard 62, and developed to provide the code required 15 cfm/person of ventilation (point 15). The building borne contaminants are covered by the rates in Table 121-A of the Standard and are used as a minimum rate for the control of DCV systems (Section 121 (c) 4 E). Also, the proposed requirement does not impact schools (point 3).
- **Ambiguous DCV Size Limitation:** The proposed requirement is triggered by three tests: 1) it is a single zone system; 2) the system has an outdoor air economizer and 3) the system primarily serves densely occupied spaces. The effective size of units meeting these tests is 6-1/2 tons and greater. Economizers are only required on systems that have cooling capacities greater than 75,000 Btuh (Section 144 (e)) and densely occupied spaces like theaters, assembly areas and others are typically several thousand square feet (and designed for 200 ft²/ton or less). We believe that the requirement is adequate as written but would be willing to add a size limitation of 6-1/2 tons or greater if that addresses Ms. Jenkins' concerns.
- **Incomplete DCV Control Specifications:** The proposed requirement actually addresses these concerns better than the existing 2001 Standards requirement. It is also more detailed on control and performance issues than any other control requirement in the Standards. We have tried to limit the Standards to requirements for manufacturing and


installation issues that are easily enforceable. We are adding an acceptance requirement for DCV. Design guidance (such as placement of diffusers for ventilation effectiveness and placement of DCV sensors to avoid false signals) will be added to the Non-residential compliance manual.

- **Implementation of Pre-Occupancy Purge Requirements:** As stated in point 6 above, the proposed requirement includes the existing pre-occupancy purge provisions. These can be easily implemented through scheduling of system start-up. The issue of improving enforcement of the pre-occupancy purge provisions exists whether or not our proposed expansion of the DCV requirement is implemented.

I hope this letter sufficiently addresses the issues raised by Ms. Jenkins, and would be glad to discuss any of these issues in further detail with CEC and ARB. Mike Schell will also make himself available if appropriate.

Please give me a call if you have any questions.

Sincerely,
Taylor Engineering LLC

A handwritten signature in black ink, appearing to read "Mark Hydeman". The signature is fluid and cursive, with a long horizontal stroke at the end.

Mark Hydeman, P.E.
Principal

CC: Peggy Jenkins
Tom Phillips
Bryan Alcorn
Charles Eley
Steve Taylor
Andy Persily
Jim Braun
Mike Schell
Rod Valenta
Jon Leber